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EDITOR, C. A. CHANT ASSISTANT EDITOR, F. S. HOGG
David Dunlap Observatory
Richmond Hill P.O., Ont.

ASSOCIATE EDITORS

R. MELDRUM STEWART
Dominion Astronomer
Ottawa

J. A. PEARCE
Head Astronomer
Dominion Astrophysical Observatory
Victoria, B.C.

J. PATTERSON
Controller of the Meteorological Service of Canada, Toronto

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THE JOURNAL

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THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

VOL. XXXVII, No. 2 MARCH, 1943 WHOLE No. 322

RECENT PROGRESS IN ASTRONOMY

By FRANK S. HOGG

(The Address of the Retiring President of the Royal Astronomical Society of Canada)

AS we meet for this fourth war-time Annual-At-Home of our Society, it seems appropriate for the retiring president to renew an old custom of presenting a report on recent progress in astronomy. Before considering the advances in astronomical research, I wish to make a few remarks as to the welfare of the Royal Astronomical Society of Canada.

A most noteworthy event, which has been a source of satisfaction to the members of the Council and of the whole Society, has been the formation of a new Centre in Quebec City. During the past year the negotiations have been completed whereby a young and successful society, the Cercle Astronomique de Quèbec, has become affiliated with our Society. We welcome this new French-Canadian Centre, and congratulate it on the founding of a fine observatory in one of the martello towers of the Citadel at Quebec. This observatory will serve as a headquarters for the society.

Special reference is also due to the other centre in the Province of Quebec, at Montreal. For many years there has existed in Montreal one of the largest centres of our Society. Within the past year the membership and enthusiasm of that Centre have been rapidly increasing, until now it has (with over 250 members), I believe, the largest membership of any of our centres at any time.

All over the country the interest and membership of the Society

have been well maintained. Despite the absence of many members on war duties, the increasing diversion of the energies of other members into war-time activities, and the difficulties of transportation, the reports of the various centres show that our astronomical activities are continuing.

Including members added since the report of the General Secretary, the membership roll of the Society is now much the largest in our history. Difficulties in maintaining our many foreign subscriptions have been more than offset by the increased circulation of our JOUNAL and HANDBOOK in Canada and the United States. The prosperous state of our membership roll, finances and publications are due to the cooperation of the officers of the various centres, of the General Council and of contributors to our publicaitons. To them the retiring president expresses his own appreciation and that of the other members of the Society. Apart from the welfare of our own organization it is a great satisfaction to know that in such times as these so many people are finding interest and relaxation in the hobby of astronomy.

Turning to an examination of recent progress in international astronomical affairs it is encouraging to see the amount of research of the highest importance which is still being carried on throughout the world. The staffs of many observatories are greatly reduced through absence of members on war service, by the prosecution of technical research on war problems or by special instructional work. The remaining members of the staffs are, in many cases, largely occupied with maintaining the more routine and less spectacular observational programmes of the observatories. Yet astronomical publications still show that many interesting and important researches are being completed.

It is possible to choose only a few of these researches for discussion in a brief survey of this type. The selection has been made, not so much on the basis of the estimated relative importance of the subjects, but rather to include some results from a wide variety of fields of investigation. Thus this survey starts from investigation of meteorites at, or even below, the surface of our own planet, and moves outward, by increasingly great steps, through the solar system, the stellar system, and on to the outer galaxies.

Meteorites. Since meteorites are the only solid samples of matter of extra-terrestrial origin which are available for laboratory examination on the earth, they should be of the very greatest importance as a source of astronomical knowledge. The collection of meteorites for study in the past has usually resulted either from accidental discovery of objects on or just below the surface of the ground, or from an intensive search of a small region around an observed fall. Recently Nininger has developed a very successful "magnetic rake" which can be towed over the ground to gather up iron meteorites from the surface of the earth.

However, mathematical studies of the penetration of the ground by falling meteorites has indicated that the largest meteorites must usually be far too deep to be accidentally found even by deep plowing. Lincoln La Paz, of the University of Ohio, has estimated that 100,000 times as much meteoritic matter lies buried below plow depth as lies above this depth. This emphasizes the need of developing a method of detecting buried meteorites. La Paz[1] has carefully investigated the methods of detecting such hidden objects, and, in the case of iron meteorites, has developed a startlingly successful technique.

The new apparatus is an adaptation of a bomb detector constructed by Theodorsen in 1930 for the purpose of locating old unexploded aerial bombs at Langley Field, Virginia. This detector consisted of three large symmetrical horizontal co-axial coils. The middle coil was a primary, supplied with an alternating current. The outer balanced secondary pick-up coils were connected differentially in series across a telephone receiver. When no metal is present in the field, the field is symmetrical, and no current passes through the receiver. Any nearby metal distorts the field, causing a current to be induced in the pick-up circuit, and producing a sound in the ear-phones.

The original detector was large and heavy. The coils were three feet in diameter, requiring two men to carry them. The power was supplied by a motor generator mounted on a truck. Thus, while valuable for use on an air field, it was not suitable for field work in meteorite searches, carried on often in much less accessible country. La Paz and his collaborators have greatly reduced the size and

[1]La Paz, *Pop. Ast.*, vol. 50, March 1942, pp. 157-165.

weight of the detector.[2] It can now be readily carried, even in very rugged country, by one man. The power consumption is greatly reduced by replacing the motor generator by a vacuum-tube oscillator circuit for the primary coil. In one model the total weight has been reduced to only fifteen pounds.

With such meteorite detectors he has had great success in locating buried meteorites. He gives results of one study three years ago at the site of the Odessa Crater in Texas. Here sporadic searches over several years had yielded very little meteoritic matter. In September 1939 thirty men searched two weeks by digging, but found only one meteorite, which weighted less than one pound. Then at the same place an expedition from Ohio conducted a twelve-hour search with one of their detectors. Thirteen iron meteorites and a number of shale balls were located. Twelve of the meteorites ranged in mass from one to thirty pounds, while one was an immense body of several hundred pounds' weight.

The smaller of these meteorites were found from eight to twenty inches below the surface, while the largest was detected despite being buried to a depth of three feet. The combination of this powerful means of finding buried meteorites, and modern methods of analysing them, such as age determination by radio-activity, should add greatly to our knowledge of this important branch of astronomical study.

Solar Parallax. It is a fairly simple matter to determine the shapes and relative sizes of the orbits of the earth and the other planets moving about the sun. To determine the dimensions in terms of standard units of length on the earth—such as the mile—is a very exacting problem. The mean distance of the earth from the sun is of great importance since this distance, the astronomical unit, serves as the basis for all our measures of the distance of the stars.

The direct method of finding the sun's distance is by measuring its parallax. The parallax of the sun is the difference in angle of the sun's position as viewed from two ends of a base line whose length is the earth's equatorial radius. The difficulty is that this angle, less than nine seconds of arc, is so small that the accuracy of the final distance is not great. An increase in accuracy may be obtained if, instead of measuring the parallax of the sun, the parallax of a nearer

[2]Wisman, *Pop. Ast.*, vol. 50, April 1942, pp. 216-222.

object is measured. The gain in accuracy is due to the larger parallax angle to be measured, and to the use of a smaller object, whose position may be much more critically measured than that of the big disc of the sun.

An excellent object for the purpose is the tiny asteroid (433), Eros. This object, found in 1898, moves in a very eccentric orbit, and may come within about fifteen million miles of the earth. In 1931 it was due to approach within 16,200,000 miles of the earth—its closest approach since its discovery. A great international programme of observation was organized for observation of its position at that time. Observatories in England, Belgium, Germany, Italy, Spain, Czechoslovakia, Russia, India, China, Japan, Algeria, South Africa, the United States, Australia and the Argentine Republic took part in the work. Twenty-five observatories, using thirty-two telescopes secured a total of 2847 usable photographs. Owing to the wide distribution in both geographical location and time of these observations, the combination of the positions of the asteroid gives much the most accurate data ever obtained for determining distances in the solar system.

The reduction of the international observations was undertaken by Dr. H. Spencer Jones, the Astronomer Royal at Greenwich, England. This vast undertaking has now been completed and the results have been recently published by Jones.[3] For the determination of the most accurate positions from such a wide range of instruments and observing conditions, the analysis had to be carried on with utmost attention to systematic errors. The measures were combined and recombined in many ways, in order to reduce errors and determine the best relative weights of the observations.

From the measures of the parallax of Eros, and the elements of the orbit of Eros relative to that of the earth, the parallax of the sun was finally derived as being $8''.790 \pm 0''.001$. This corresponds to a semi-major axis of $93{,}005{,}000 \pm 9{,}000$ miles for the earth's orbit. Jones points out that the error of $0''.001$ corresponds, observationally, to the width of a hair as viewed from a distance of ten miles. This

[3] *Mon. Not. R.A.S.*, vol. 101, pp. 356-366, 1942. An interesting historical survey of the methods of determining the sun's distance is given by Jones in *Endeavour*, Jan. 1942.

is the most accurate determination yet made, and many years may elapse before a better value is determined. It is a satisfaction that the energy and cooperation of so many astronomers throughout the world, and the long and masterful reduction of the results by the Astronomer Royal have resulted in such a precise re-determination of the standard astronomical unit.

The Moon's Mass. The same observation of the position of Eros served as a source for determining another fundamental astronomical quantity—the mass of the moon in terms of the earth's mass. This determination depends on the fact that while we speak of the moon as revolving about the earth, actually both the earth and moon revolve about the common centre of gravity of the earth-moon system. Since the earth is about eighty times as massive as the moon, the common centre of gravity is only about one-eightieth of the earth-moon distance from the earth's centre. Thus the centre of gravity is only some 3000 miles from the earth's centre or a thousand miles below the earth's surface.

During the course of a month the earth moves in an orbit of about 3000 miles radius about the centre of gravity. Thus half the month the earth is too far ahead in its orbit and, the other half, too far back. The result is that each month nearby objects, such as Eros, are appreciably shifted back and forth with respect to the more distant stars. Measures of this shift in angle serves as a means of determining the accurate distance of the centre of the earth from the centre of gravity of the earth-moon system, and hence the accurate ratio of mass of the moon to that of the earth.

The reduction of these observations is a long and difficult process. Jones' discussion of the parallax plates of Eros results in a new value of the mass of the earth as 81.271 ± 0.021 times that of the moon. This ratio is important in analysis of the motion of the moon, and in studies of luni-solar precession and nutation. As with the sun's distance, this new determination is based on the most extensive set of observations ever made.

The Solar Corona. Another field in which recent research has been spectacularly successful is in the study of the solar corona.[4] The great greenish white solar corona, stretching hundreds of thousands of miles outward from the eclipsed sun, and so markedly different in

colour from the brilliant red prominences, has always been one of the most beautiful phenomena seen by observers fortunate enough to have clear skies at the time of total solar eclipses. Only within the past decade have improved photographic methods, and the "coronaviser" given the first opportunities of studying even the bright inner corona at times when the sun is not eclipsed. That these methods have had any success is due to the fact that the spectrum of the corona includes one particularly strong green line.

Nearly three quarters of a century ago, at the eclipse of 1869, Young and Harkness obtained spectroscopic observations of the corona. They observed a brilliant green emission line in the spectrum. The wave-length of this line, later measured with increasing accuracy as λ 5303.7 A, was found not to correspond to the chief line of any known terrestrial element, and was long attributed to an extra-terrestrial element, christened coronium. In the sun and in gaseous nebulae other unknown lines had been attributed to unknown elements, helium and nebulium. Helium was later found on the earth; but neither nebulium nor coronium seemed to fit into the periodic table of our chemical elements.

When about fifteen years ago the nebulium lines were found to be produced by transitions, under unusual conditions, in the atoms of oxygen and nitrogen, many attempts were made to similarly attribute coronium—now represented by many fainter lines as well as the green line—to common terrestrial atoms. Applications of the same methods as had been so successful in the case of nebulium were all in vain. Recently the physicist Bengt Edlén, by very bold methods, has apparently succeeded in reducing the mystic element coronium to the earthly elements, iron, nickel and calcium.

The startling feature of Edlén's identification is that these elements yield the coronal lines only when they are far more highly ionized than had before been considered possible. The coronal line 5303.7 A, he identifies as being due to Fe XIV, that is, iron atoms from which 13 of the outer electrons have been removed. The three next strongest lines of the corona correspond to lines of Fe XIII, that is, iron atoms with 12 electrons removed. Grotrian identified two other

[4]A summary of this subject was published in this JOURNAL, September 1942, pp. 312-316, by William Petrie.

lines as due to Fe XI and Fe X. These six iron lines together account for over ninety per cent of all the intensity of the coronal emission spectrum. Other fainter lines are attributable, by the same method, to multiply ionized nickel and calcium.

For comparison, it may be noted that in the solar photosphere the atoms of iron are neutral or singly ionized. To ionize iron to the extent indicated in the corona would require a temperature of millions of degrees. The spectra of prominences and the sun's upper atmosphere indicate that ionization is somewhat higher above than in the photosphere, but ionization temperatures of a million degrees are of a quite different order.

Edlén's identifications appear well founded. They completely alter our picture of the region around the sun. Various theories have been recently put forward as to how this extreme ionization may occur and persist so far above the sun's cool photosphere. It should be noted that, as well as the emission spectrum, the light of the corona is made up of a reflected Fraunhofer spectrum which is too well defined to permit explanation as due to scattering from high-velocity particles. As further study continually reveals that the sun—the only star we study in detail—is increasingly complicated in structure, it appears that we must be increasingly alert in observing and interpreting the spectra of the myriads of stars too far away to present us with such detailed and contradictory phenomena.

The Triple System of 61 Cygni. Moving outward from our solar system to the stars beyond, a logical stopping-place is at the famous nearby star 61 Cygni. This fine double star has long been of great interest. It was the first star for which the distance from the earth was determined. This was done by Bessel just over a century ago. With a parallax of 0″.294, corresponding to a distance of only 11.1 light-years, it is amongst our nearest neighbours in space. As the two visible components are of the 5th and 6th magnitudes, and separated by over twenty seconds of arc, this pair has always been a popular show-piece for amateur observers.

Recently Dr. Strand,[4] of the Sproul Observatory, has studied the relative motions of the two components for the determination of an accurate orbit. He had available a series of very accurate photographic observations from Potsdam, Lick and Sproul. The pair of

stars has been found to be revolving in a fairly eccentric orbit in a period of 720 years. The more recent accurate observations indicate, however, that this motion cannot be represented as a simple Keplerian motion of the two stars. Like many other systems, it appears from Strand's work that the perturbations of the motion are due to a third invisible component.

One of the brightest components is oscillating in a small elliptical orbit as it revolves about the other. It is impossible to saw which one, since the positions of the two stars are only measured relatively. The period of this motion has been found to be 4.9 years, the eccentricity 0.7, and the semi-major axis only 0".020.

The most reasonable explanation of the observed motion of the bright star is that the faint (invisible) companion producing this motion has a mass of only one-sixtieth that of the sun. As Jupiter is about one thousandth as massive as the sun, the third component of 61 Cygni is only 16 times as massive as our planet Jupiter.

This new object is thus of a type hitherto unknown. It has about one-ninth as much mass as the lightest known star, and sixteen times the heaviest known planet. Should it be considered a very dwarf star or the first planet to be found beyond the limits of our solar system? Will other such objects be found? Careful studies of the motions of other nearby doubles show that others have companions of small mass, but so far none has been found of comparable lightness. This work is indicative of the great importance of the photographic method in measuring accurately double star positions.

Bright-line Spectra of Nebulae. In 1864 Huggins succeeded in observing the spectra of a number of those faint hazy spots in the heavens which have long been called nebulae. His observations showed that the spectra were of two main classes. Some nebulae, such as that in Andromeda, gave essentially continuous spectra, which could be interpreted as indicating an origin in a cluster of cloud of stars. Others, such as the Orion nebula, showed a few bright emission lines, usually associated with an extended volume of radiating gas.

The spectra of the bright-line nebulae, of both planetary and diffuse types, showed in general the Balmer lines of hydrogen, a few lines of helium, and the several bright lines of then unknown

[5] *Pub. Ast. Soc. Pac.*, February 1943, pp. 29-32.

origin, called nebulium. Later studies, notably by Wright at Lick Observatory, revealed the presence of a number of fainter lines. The elements chiefly responsible for the luminosity were hydrogen, helium, carbon, nitrogen and oxygen, in various stages of ionization and excitation. Work of Bowen and of Zanstra quantitatively accounted for the observed intensities of the emission.

The observations of the fainter lines has always been a very difficult problem. The Lick Observatory has long taken a lead in developing techniques and programmes to obtain these faint spectra with exposures of a reasonable number of hours—or nights. Recent developments by Professor Bowen and the late Dr. Wyse,[6] [7] who was killed in a collision of U.S. dirigibles while on war research, have greatly increased the number of lines observed. Using a three-prism spectrograph with a very short camera lens (F/1.9), and exposures up to twenty hours, they succeeded in measuring the wave-lengths and intensities of 270 lines in the spectra of a total of ten gaseous nebulae. Improvements in speed resulted from three new scientific developments—the coating of optical surfaces with non-reflecting films, the use of Bowen's "image-slicer" to superpose much more of the nebular image on the slit, and increased speed of photographic emulsions.

Of the 270 lines, about sixty per cent, including all the stronger lines, have been identified. In addition to the better known hydrogen, helium, carbon, nitrogen and oxygen, the list of elements identified in nebulae now includes flourine, neon, magnesium, silicon, sulphur, chlorine, argon, potassium, calcium, iron and nickel. In some cases several stages of ionization are present.

From the intensities, excitation and ionization, it was possible to determine not only the qualitative, but also the quantitative chemical composition of the nebulae. It was found that the abundance of the chemical elements is remarkably similar from nebula to nebula. This is true even when planetary nebulae, which are probably produced by material ejected from their central stars, are compared with diffuse nebulae, such as in Orion, which presumably were originally widespread diffuse matter. This similarity apparently would indicate that

[6] *Lick Obs. Bull.*, vol. 19, p. 1, 1939.

[7] *Astroph. Journal*, May 1942, pp. 356-385.

the transmutations within the central stars have little altered the chemical composition of matter.

The great increase in the number of elements identified, and measures of their abundances allow detailed comparison with our own sun. Here again the composition is remarkably similar, indicating once more the uniformity of chemical composition of the universe. Another feature of this analysis is that the nebulae show no marked differentiation into carbon and nitrogen branches, such as is present in Wolf-Rayet stars, or into oxygen and carbon sequences, as in the M and N stars. This programme has been a beautiful and very fruitful piece of observational technique.

Star of 1054 A.D. Another research which has made great progress in the last few years has been the study of an event which was seen shortly before the Norman conquest of England. This was the appearance, in 1054 A.D., of a supernova in the constellation Taurus in our galaxy. The modern evidence of this event is seen in the famous Crab Nebula. This object is a bright-line gaseous nebula near the star ζ Tauri. It is a fuzzy, moderately bright patch, about 6′ by 4′, catalogued as No. 1 by Messier. Its oval shape and distribution of brightness gave it the name "The Crab."

Twenty years ago Lampland, from measures of a pair of photographs made eight years apart, found proper motions of the outer regions indicating an expansion of the nebula. More accurate measures were made by Duncan, in 1939, using Mount Wilson plates with an interval of thirty years. These showed a very regular outward displacement. Extrapolating these motions backward, it was found that material had all started from a point near the apparent centre of the nebula. From the rate of this expansion, the time of origin of the expansion would appear to be about 800 years ago.

As well as the proper motion evidence of the expansion, spectroscopic observations had indicated an expansion of about 1300 km. per second. If—as is indicated by the proper motion component—the expansion is spherically symmetrical, the combination of the two types of measures permits the calculation of the distance and absolute dimensions of the nebula. Duncan determined the distance as 4100 light-years, and the diameter of nebula as about six light-years.

This expansion suggested, years ago, that the motion probably

originated in a nova-like outburst. Lundmark had noted a Chinese reference to a "guest-star" in our constellation Taurus, in the year 1054 A.D. Professor Duyvendak,[8] of Leiden, last year published an important discovery of several more detailed early Chinese records of this "guest-star." It must have been a spectacular object, since the records state that it was visible by day, like Venus, and remained visible for 23 days. It remained visible in the night skies for over a year.

While this nova outburst occurred nearly nine hundred years ago, instead of the eight hundred years indicated for the expansion time of the Crab Nebula, the closeness of position of the two objects, both in time and position, makes it very probable that they are identical. Future measures, with longer available intervals of time, and better methods, should date the origin of the Crab Neubla more definitely.

If this identification is correct, the distance of the nebula, as determined from the expansion, and the apparent magnitude of the nova, permit a determination of the absolute magnitude of the nova. It is at once evident that this outburst must have been of the rare supernova class. To have remained visible in the daytime (magnitude -3.5) for 23 days, its apparent brightness at maximum must have been about -5. Correcting this for the estimated space absorption in this region, and using the distance 4100 light years, the absolute magnitude of the supernova at maximum is found to be about -16.5. This is comparable to the brighter supernovae in outside galaxies.

During the past year the nebula has been further studied at Mount Wilson. Baade,[9] who has obtained such spectacular results in photography with red-sensitive plates, has taken photographs of this nebula through red filters selected to transmit narrow ranges of wave-length. In one case the filter range includes the strongest emission lines; in the second, its action is to exclude emission lines and transmit chiefly continuous spectrum. In the emission line photograph the nebula shows a wealth of fine filaments; in the continuous range, the nebula is smaller, fuzzier, and the sharp filaments are lacking. Moreover, about eighty per cent of the nebular light comes from the continuous, and only twenty per cent from the

[8] *Pub. Ast. Soc. Pac.*, April 1942, pp. 91-94.

[9] *Astroph. Journal*, September 1942, pp. 188-198.

bright line spectrum. Baade notes that such filter photographs, owing to their very intricate detail, should soon provide much more accurate measures of the rate of expansion.

This old supernova and large expanding nebula are near enough and bright enough to present observational data which should be of fundamental importance. The remnant of the original star is not definitely identified, though it may be a star of magnitude 15.9. How can such a faint star produce a nebula of primarily continuous spectrum several hundred times brighter than itself? Minkowski,[10] of Mount Wilson, has worked out an ingenious theory of the production of this luminosity by interaction of the central star's radiation with free electrons in the vicinity of atoms. On this basis, the faint central star must be intensely hot, and only twice the diameter of the earth—thus a blue dwarf.

It is fortunate that this object was near enough to us to allow a combination of proper motion, radial velocity, colour filter and spectroscopic observations, together with Chinese records and theoretical speculations. Whatever the final picture of the present state of this nebula and star may be, we are sure to find it one of the most remarkable objects in the universe.

Rotation of Galaxies. As a final step in a survey of recent researches, we move outward through hundreds of thousands of light-years to the nearer of the external galaxies. Work at the Lick Observatory during the past few years has greatly increased our knowledge of the rotation of these nebulae. This is a very important problem both from the point of view of the study of these objects, and for interpretation of the observed rotation of our own galaxy.

The observation of the rotation of these extra-galactic nebulae is a very difficult problem. Owing to their great distances it is now apparent that the proper motion component of the rotation must be very small. Probably centuries would elapse before our present photographs would show measurable rotational proper motions. Thus information as to the rotation must be derived from the spectroscopic observations of the radial velocity component of these motions. The difficulty arises from the extreme faintness, for spectroscopic analysis, of all except the bright central portions of these nebulae.

[10] *Astroph. Journal,* September 1942, pp. 199-213.

As early as 1914 Slipher first observed an inclination of the spectral lines in the central region of the Andromeda nebula, indicating axial rotation. Pease, with an exposure of 79 hours, was able to extend measures only to a distance of about five minutes of arc, or 500 light-years, from the centre. For this very small fraction of the total diameter of the nebula, the velocity of rotation increased almost linearly with the distance from the centre. In other words, the small central core was rotating as a solid object, in a period of about ten million years. H. W. Babcock [11] in 1939, and Mayall and Aller [12] in 1941, have extended measures in the Andromeda nebula, and in the fine open spiral M 33, in Triangulum, to much greater distances.

To reach out to the fainter outer regions, when the exposure times of the general star clouds would be impossibly long, advantage was taken of the existence of the patches of bright-line nebulosity which are scattered through these nebulae. On account of the bright-line character of the spectrum a much shorter exposure-time is necessary to secure measurable spectra of these nebulous objects. With these extended observations it was found that the uniform increase of velocity with distance is restricted to the central region; that beyond these the velocities decrease. There are considerable differences between the curves for these two nebulae.

For the Triangulum nebula, Mayall and Aller, using 25 bright-line patches, found that the velocity increases uniformly throughout the main central condensation to a distance of 16 minutes, or 3500 light-years, from the centre, so that this region rotates as a solid body. Beyond this, out to 30 minutes, or 6000 light-years, the rotational velocity decreases slowly with distance, just as our outer planets have progressively lower velocity with greater distance. The maximum rotational velocity, at 3500 light-years, is about 120 km. per second, while the velocity at the outer limit of their measures falls off to about 60 km. per second at 6000 light-years.

Correcting these velocities for the inclination to the line of sight, estimated as 33 degrees, Mayall and Aller determined the rotational period of the nebula. The inner region rotates in about 60 million

[11] *Lick Obs. Bull.*, vol. 19, p. 41, 1939.

[12] *Astroph. Journal*, January 1942, pp. 5-23.

years, while the outer edge requires from 100 to 200 million years. From these rotational periods, Mayall and Aller estimate the mass of the Triangulum nebula as 1700 million times that of the sun. This is only about one per cent of the mass of the Andromeda nebula, as similarly estimated from Babcock's measures, or of our own galaxy. This result again stresses the existence of normal nebulae and giant nebulae, such as Andromeda and our own galaxy.

Two other researches on the rotation of these nebulae might be mentioned. Wyse and Mayall[13] have developed a mathematical method of analysing the rotational velocities to be expected at various distances from the centre as a function of the mass-distribution in the nebula. In this year of commemoration of Isaac Newton it should be recalled that he had to develop mathematical methods to solve the similar case for attraction of a simple spherical object. The complexity of a non-spherical non-uniform distribution is very great. As increasingly extensive observational material on this problem becomes available, the mathematical analysis will yield increasingly definite results as to the mass-distribution in the nearer outer galaxies.

The other problem recently solved is that of the direction in which some at least of these nebulae rotate. Lacking proper motion data, the spectroscope merely tells which parts of the nebulae are approaching and which receding. In general we can tell from the shape how much but not necessarily in which way the nebula is tilted, and hence whether the spiral arms are winding or unwinding. However, in a few cases, where there is marked absorption in the central plane of the nebula, it is possible to tell which way the nebula is tilted. When such nebulae are investigated for rotational velocity, the direction of rotation with respect to the spiral structure can be determined. For the few nebulae so far examined, the spiral arms are found to be trailing in all cases. This again was a very difficult observational task.

From this survey of research findings in a selection of fields, it is apparent that astronomy is still being actively advanced. With increasing war activities the output of astronomical discoveries will undoubtedly fall off in the coming years. Major construction, such

[13] *Astroph. Journal*, January 1942, pp. 24-47.

as that of the 200-inch telescope, is indefinitely postponed. It is to be hoped that soon, with the return of peace, the many advances in scientific technique which have resulted from war-time research will open the way for new advances in astronomical discovery.

David Dunlap Observatory,
Richmond Hill, Ontario.

PLATE III

REV. W. G. COLGROVE, M.A., B.D.

To whom was awarded the Chant Medal for 1942.

In the instrument shop of the Hume Cronyn Memorial Observatory, University of Western Ontario, London, Ont.

THE THIRD ANNUAL AWARD OF THE CHANT MEDAL

By H. R. KINGSTON
Chairman of the Committee

(With Plate III)

THE third annual award of the Chant Medal by the Royal Astronomical Society of Canada has been made to Rev. W. G. Colgrove, M.A., B.D., of London, Ontario. He was nominated for this honour by Dr. G. R. Magee for very substantial services rendered in the field of the popularizing and teaching of astronomy.

During the past ten years, Mr. Colgrove has designed and constructed a series of excellent instruments for demonstrating clearly and effectively many astronomical phenomena. The series includes several planetaria; a sotellunium for demonstrating, as the name implies, relationships and relative motions in the sun-earth-moon system; an instrument demonstrating the rotation of Mars and the revolution of his moons; a set of models of the planets all on one scale (8000 miles to the inch) that may be taken outside and mounted on pillars set at proper relative positions to represent the solar system on a single scale of distances (1 million miles to the foot); stellar radiant showing the one hundred brightest stars in their proper directions and relative distances; star maps; model of our galaxy; demonstration refracting telescope with accessories, demonstrating reflecting telescope, etc. These instruments have been of inestimable value in the teaching of astronomy to students at the University of Western Ontario and especially to the large groups of public school teachers who take the astronomy course in the Summer School of the University and carry the work directly back to their schools throughout the Province and even beyond its borders. Several school boards have been supplied with duplicates of some of these instruments, which are being used also at the Royal Air Force Training School at Goderich.

Mr. Colgrove has contributed to the JOURNAL of the Royal Astronomical Society of Canada a series of articles on the planets and has compiled a book of facts regarding the solar system. For several years he has given popular lectures on astronomy and has held obser-

vation meetings with his telescope at school centres, in the parks and at the University. Through his initiative and untiring energy the University of Western Ontario put on an excellent astronomical display for three successive years at Western Fair, London. Since the opening of the Cronyn Memorial Observatory in 1940, he has demonstrated his instruments and given observations through the 10-inch refracting telescope to over three thousand visitors to the Observatory. He has been keenly interested in sun-spots and follows their activity regularly. Comets, too, never fail to claim his attention, and he delights in showing them to the Observatory visitors. He has also shared in the use of the splendid 8-inch Schmidt Camera with which the Observatory is fortunately equipped. Further, it should be added that every piece of equipment in the Observatory receives his constant and meticulous care. When repairs are necessary he is usually able to make them in the Observatory Work Shop, where his mechanical and artistic qualities are ever turning out also some instrument pleasing to the eye and effective in demonstrating some astronomical fact. His only regret, he states, is that the days are too short to enable him to accomplish all he would like to do. For the past ten years he has been a very active member of the London Centre of the Royal Astronomical Society of Canada and for two years was its energetic president.

Mr. Colgrove was one of those fortunate enough to see the Dresden Meteorite when it passed over London in the early evening of July 11, 1939, and he was indefatigable in his efforts to secure the object for the Observatory. It was finally obtained through the generosity of the London Life Insurance Company.

From childhood Mr. Colgrove has been interested in nature—flowers, trees, rocks, birds, insects, etc. In 1882 he saw the great daylight comet lie across the sky for days together and recalls that it was a subject of great interest and, to many, of very real apprehension. This phenomenon greatly stirred his interest in astronomy, which was further heightened three years later when he observed a brilliant meteor burst with a loud thunder-like crash over a field where he was working on the farm of his boyhood home, just across the road from the site of the present Cronyn Memorial Observatory. He saw smoke rise and fragments fall but could not find any of the latter. A

gift of a telescope about this time was all that was needed to start him on a life-long hobby. In 1893 while visiting the World's Fair in Chicago he was greatly intrigued by the giant 40-inch Yerkes Telescope which was set up at the Fair, and brought home a sketch of it.

Mr. Colgrove is not only a wide-awake observer of nature; he possesses also a natural gift for drawing and designing as well as an inborn mechanical bent. On one occasion his mechanical urge overcame his academic interests to such an extent that he "mitched" school (the only time he ever played hookey) and went to the Grand Trunk Station to watch the big locomotives. For five years he was apprenticed to the Knowles Lithographing Company of London and later was the foreman in similar establishments in Rochester and Montreal. During these years he maintained a lively interest in art and won several prizes in this field. These experiences provided the background which has now in his years of retirement from the active ministry of the United Church of Canada given Mr. Colgrove a delightful hobby and enabled him to make a very worthy contribution to astronomy. We trust that he may be spared in health and strength for many years to enjoy the honour which the Astronomical Society has conferred upon him and to carry on the work of giving pleasure and instruction to many, both old and young, as he shows them some of the interesting objects in the skies and leads them to a finer appreciation of the wonders of the heavens.

Mr. Colgrove received the medal in person at the annual at-home of the Society, January 25, 1943.

MINUTES OF THE ANNUAL MEETING OF THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

The Annual General Meeting of the Society was held in the McLennan Laboratory, Friday evening, January 15, 1943, Dr. F. S. Hogg, President, in the Chair.

Minutes. The minutes of the 1942 Annual Meeting having been published in the JOURNAL were taken as read and approved.

General Secretary's Report. Mr. E. J. A. Kennedy, General Secretary, reported a membership of 991 as against 887 in 1941. Quebec Centre, recently affiliated, has 59 members. An encouraging increase has been shown by Montreal Centre.

A number of our members throughout Canada are engaged in war work of various kinds, and special mention was made of the contribution of Dr. Hogg, our President, in the matter of aerial navigation.

Reference was made to the Building Fund and to the death of members of the Council during the year.

The report was adopted.

General Treasurer's Report. Mr. J. H. Horning presented the report of the General Treasurer. At the beginning of the year there was on hand in the General Fund $95.67. With a gratifying increase in receipts because of larger membership, and from the sale of publications, the balance at the end of December was $717.06. The Building Fund, and the Life Membership and Southam Press accounts also have satisfactory balances, the details of which will appear in the published statement.

On motion, duly seconded and carried, the report was adopted.

Librarian. Dr. Millman, the Librarian, being absent on war service, the report was presented by Dr. Best, who is acting in his absence. Owing largely to the war, there has been a decrease in the number of periodicals received, especially from Europe, none coming from some countries. 170 books were borrowed from the Library, and $38.60 was spent for new books, with an additional expenditure of $65.34 for binding. During the year Rev. C. H. Shortt donated to the Library Volumes I to XXXVI of the JOURNAL.

Following the adoption of the report discussion took place regarding publishing a list of the books on hand, and on motion the matter was referred to the Council for consideration.

Curator. Mr. R. S. Duncan reported regarding the telescopes and lantern slides.

Scrutineers' Report. Miss E. M. Budd and Mr. F. L. Troyer, having counted the ballots, announced that 206 had been cast as compared with 153 last year. As a result of the voting, the following were elected:

Honorary President—The Hon. Duncan McArthur, Ph.D., Minister of Education for the Province of Ontario.

President—Miss A. Vibert Douglas, Ph.D., Kingston.

First Vice-President—A. E. Johns, Ph.D., Hamilton.

Second Vice-President—H. Boyd Brydon, Victoria.

General Secretary—E. J. A. Kennedy, 198 College St., Toronto.

General Treasurer—J. H. Horning, M.A., Toronto.

Recorder—H. W. Barker, Toronto.

Librarian—P. M. Millman, Ph.D., Toronto.

Curator—R. S. Duncan, Toronto.

Members of the Council—C. S. Beals, Ph.D., Victoria; S. C. Brown, Toronto; G. E. Campbell, M.A., Hamilton; J. W. Campbell, Ph.D., Edmonton; W. G. Colgrove, M.A., B.D., London; DeLisle Garneau, Montreal; Mrs. F. Shirley Jones, Ph.D., Toronto; Mgr. T. W. Morton, Winnipeg; P. H. Nadeau, Quebec; Andrew Thomson, Ph.D., Toronto; M. M. Thomson, Ottawa; G. M. Volkoff, Ph.D., Vancouver.

Auditors. On motion, Messrs. Andrew Thomson and F. L. Harvey were re-appointed Auditors.

In the opening of the new books and the inaugurating of a more complete system of bookkeeping, Mr. Kennedy had spent a lot of time; and through the good offices of his Auditor a complete financial survey had been made. An honorarium of $20.00 was voted to the Auditor for this survey, and the Society's appreciation was extended both to him and to Mr. Kennedy.

Thanks. The thanks of the Society was given to all the Officers for their faithful services during the year.

The meeting then adjourned.

H. W. Barker, *Recorder.*

Report of General Secretary for 1942

It is encouraging to report that in spite of changed conditions due to the war, the Society's membership has increased. Last year the figure was 887, this year 991. Quebec, a new Centre established this year, has provided 59 new members. Montreal shows a wonderful addition of 66. They listed 80 in 1941, 146 in 1942. As a matter of interest the Montreal Secretary has sent in another list of 15 more in the first week of this new year. They will be included in 1943 figures. These two Centres provide considerably more than our total increase which means of course that some other Centres report a decrease. A complete list is appended.

The nucleus of the Quebec City Centre was a French Canadian Astronomical Society. They are showing much enthusiasm and the General Council is gratified and pleased to welcome our French-speaking neighbours.

Our list of subscribers to the Journal, which includes many observatories and institutions throughout the world, shows considerable loss, due to the difficulty in reaching neutrals as well as countries at war. This temporary loss is 21.

One notable feature of the Society's activity is the preparation and sales of our publications. The demand for the Observer's Handbook continues and this without the benefit of any advertising. "The Physical State of the Upper Atmosphere", by Haurwitz, has been requested by many public libraries in the United States and Canada for their reference shelves and some technical colleges have sent in repeat orders. Owing to the generous contribution of the writers and editors of these publications the Society is enabled to make a profit on these sales. At the same time it is a direct contribution to the war effort. Both publications are being used by instructors in the Air Forces of Canada and United States. The reprints for observers are also in steady demand. The Society would be fortunate if the present authors and others would continue their contributions and thus enlarge the field of service to science and the community.

Individual members of the Society are accomplishing much in the fight for freedom. Among these are members of the Council located in Toronto, and outside Centres are no doubt doing their share.

The Chant Medal Committee, Dr. H. R. Kingston of London, chairman, has announced that the winner for 1942 is the Rev. W. G. Colgrove, M.A., B.D., of London.

We think attention should be drawn to the sums of money in bonds held by the Society as shown in the Treasurer's statement. The building fund has grown steadily through the years and was instituted with the thought of providing a suitable place for the Headquarters of the Society and a place where our telescopes could be set up for the more general use of our members. While the present is not an ideal time to extend in this way, it would seem advisable that a study of the conditions should be made and some project formulated which might perhaps attract a wealthy donor. A planetarium for Toronto is not beyond the bounds of possibility.

Hamilton Centre suffered a severe loss in the passing of their late President, N. H. Broadhead. He was a man of many accomplishments and exceedingly active in the affairs of the Society. Capt. W. M. Everall, 1st Vice-President of the Victoria Centre, died in June. He was a member of the Society for many years. We also record the death of Lieut. Geo. H. Tidy in March of this year. He was on the staff of the David Dunlap Observatory. He was a lieutenant on loan to the Royal Navy after taking a special course at the University of Toronto. He was lost in the naval battle off Java, cutting short the life of a young man of great promise.*

E. J. A. KENNEDY, *General Secretary.*

REPORT OF THE LIBRARIAN

During 1942 the following periodicals were received:

From Canada and the Empire	37
" The United States	88
" Other Countries	26
Total	151

Number of books loaned from the shelves during the year	170
Expenditure during the year—	
For New Books	$ 38.65
" Binding, etc.	65.34
Total	$103.99

*March 1, 1943.—A message has just been received that Lieut. Tidy is a prisoner of war in Japan.—*Editor.*

New Books added to the Library by purchase in 1942 were those in the list printed in the JOURNAL for March 1942, page 105.

"Essentials of Astronomy" (1942) by J. C. Duncan was presented to the Library by Mr. N. W. Devitt.

Miss Hunter donated the books and periodicals from the astronomical section of the library of her brother, the late A. F. Hunter, M.A.

The Rev. C. H. Shortt, M.A., has donated to the Library his copies of the JOURNAL from Vol. I to Vol. XXXVI. Such gifts are fully appreciated and are here acknowledged with cordial thanks to the donors.

Recently arrived are two copies of a handsome volume entitled "Pouchkine", containing articles on the great Russian poet, with many fine illustrations. They were sent by Société pour les Relations culturelles, Moscow. They are here acknowledged with appreciation. The language used is French.

P. M. MILLMAN, *Librarian.*
per D. W. BEST, *Acting Librarian.*

MEMBERSHIP ON DECEMBER 31, 1942

	1941	*1942*
Toronto Centre	190	191
Montreal "	80	146
Winnipeg "	33	36
London "	37	38
Edmonton "	46	46
Hamilton "	57	43
Vancouver "	36	31
Ottawa "	60	58
Victoria "	109	93
Quebec "	...	59
Members at large	224	235
Life Members not in Centres	15	15
	887	991
Additional Subscribers to JOURNAL	62	41

REPORTS OF THE SECRETARIES OF THE CENTRES

Toronto Centre

Meetings. During the year 1942 there were held 2 Council meetings, 11 regular meetings and 4 summer outdoor meetings. In spite of war conditions and the increased difficulties of transportation the attendance has not fallen off and the use of the larger lecture room in the Physics Building of the University of Toronto, for all lectures, has been well justified.

The leading features of the programmes were:

February 3—Miss Ruth J. Northcott, M.A.: "Pathways to the Stars."
February 17—Rev. T. Christie Innes, M.A., F.R.A.I., M.R.A.S.: "Biblical Astronomy."
March 3—Miss E. M. Fuller, B.L.S.: "Recent Astronomical Books."
March 17—Professor C. A. Chant, LL.D.: "The Magnitudes of the Stars: One Star differeth from another Star in Glory."
March 31—Mr. H. W. Barker: "Astronomical Errors in Literature."
April 14—Dr. D. W. Best: "Messages from the Stars" (spectroscopy).
June 22—Summer Outdoor Meeting.
July 20—Summer Outdoor Meeting.
August 21—Summer Outdoor Meeting.
September 21—Summer Outdoor Meeting.
October 13—Professor A. F. C. Stevenson, M.A., Ph.D.: "Recent Developments in the Quantum Theory and their Significance for Astronomy."
October 27—Mr. W. E. Knowles Middleton, M.Sc.: "Meteorological Instruments of the 20th Century."
November 10—Mr. J. H. Horning, M.A.: "The Solar System." Question Meeting.
November 24—Miss Ruth J. Northcott, M.A.: "What's New About Jupiter?"
December 8—Professor C. A. Chant, LL.D.: "Isaac Newton—His Three Hundredth Anniversary."

At each of the Spring Meetings, following the addresses listed above, there was given one of a series of short lectures on "Explorations of Clusters and Nebulae" by Dr. Helen S. Hogg.

At the Autumn Meetings a similar series of short lectures was given by Dr. F. Shirley Jones on "Astronomical Spectra."

A popular feature of recent meetings has been a 5 minute book review given by Miss E. M. Fuller, B.L.S.

An outdoor observation meeting was held in each of the June, July, August and September moons, as no planets were in suitable

position for observation. The meetings were held on the campus of the University of Toronto. Besides members of the Society, many members of the R.C.A.F., taking classes at the University, as well as many other visitors availed themselves of the opportunity for observing the skies. Many questions were asked by the visitors and answered by the members in charge of the instruments. Four telescopes were set up and long waiting lines were moving slowly forward until closing time each night.

Membership. As of December 31, 1942, there are 191 members on the roll, of whom 9 are life members. There were 18 new members elected and 17 removed for various reasons leaving a net gain of one.

We record, with deep regret, the death of Lieut. George Horace Tidy, who was killed in action while serving on the British cruiser *Exeter*.*

TRACY D. WARING, *Secretary*.

OTTAWA CENTRE

During 1942 the following public lectures were held by this Centre:

February 16—Dr. E. F. Burton: "The Electron Microscope." This lecture was held in conjunction with the local branch of the Chemical Society.

March 5—Ft/Lt. F. J. Brand: "Air Navigation."

March 19—Mr. R. Meldrum Stewart: "Life in the Universe."

April 10—The Dominion Astronomer was our host on this date, when all departments of the Dominion Observatory were open for inspection by our members and friends.

Only one Council meeting was held during the year.

The membership of our Centre was 60 at the beginning of the year; two members joined, against a loss of four—three by resignation and one by death. The membership now stands at 58. At least five of our members are on active service, among them our secretary, Pilot Officer M. M. Thomson, whose assistance will be greatly missed.

The Junior Astronomical Club, organized a year ago and sponsored by this Centre held seven regular meetings between January and April. Plans have been made for a similar series of meetings during the winter.

Our "Sky-Facts" column in *The Ottawa Citizen* was maintained, and since the last annual meeting 98 separate items have been pub-

*See footnote on page 103.

lished. It might be pointed out that only 6 of our members contributed to these, and that 97% of the items were written by 4 of them. Further assistance in this important part of our activities would be most helpful to those who carry this burden. Evidence of the interest taken in this feature is shown by a letter recently received, and by the many inquiries addressed to the column during the year. Further evidence of the increasing interest in astronomy was shown by the fact that over twenty requests were received for copies of the Society's HANDBOOK.

Through the courtesy of the Dominion Astronomer, members have, as in the past, received the Saturday Evening Program. This publication, due to war economy, is being suspended for the duration. Star maps have been and still are available to members upon request.

MIRIAM S. BURLAND, *Acting Secretary.*

HAMILTON CENTRE

During the year the Hamilton Centre held eight regular meetings in the Art Gallery and one Field Night. The chief features of the programmes were:

January 8—Dr. Wm. Findlay: "Right Ascension and Declination."
February 5—T. H. Wingham, B.A.Sc.: "A Treatise on the World's Origin."
March 5—Dr. W. H. McNairn: "Air Conditioning the Earth."
April 2—Miss S. Patterson, Ph.D.: "Other Milky Ways" (illustrated).
May 7—Dr. H. R. Kingston: "The Romance of the Calendar" (illustrated).
June 4—Field Night at the W. T. Goddard Observatory.
W. S. Mallory, M.A.: "Reflector and Refractor Telescopes."
T. H. Wingham, B.A.Sc.: "The Constellations of the Stars."
October 1—F. H. Butcher, B.A.: "Paleontology."
Dr. A. E. Johns: "Analemma."
November 5—Dr. Helen Sawyer Hogg, (Dunlap Observatory): "The Recession of the Nebulae" (illustrated).
December 3—W. D. Stewart, B.A.: "An Astronomer's Dream."

On December 3 was the annual meeting for the election of officers. The meetings during the year were educative as well as interesting. Chairman H. B. Fox rounded up a good selection of speakers during the season. We regret the loss of three members (deceased), three on active service and eight cancelled. The paid membership is now 43.

JAMES R. GRAHAM, *Secretary-Treasurer.*

Winnipeg Centre

During the year 1942 six regular meetings were held in the University Building, with programmes as follows:

January 14—Prof. W. A. Anderson: "The Sun, its Temperature and Source of Heat."
February 11—Dr. H. Saunderson: "History of the Atom."
March 11—Mr. L. T. S. Norris-Elye: "The Moon."
Mr. G. P. Morse: "Shadow Observing, The Pyramids, and Early Astronomy."
April 8—Mr. W. P. Johnson: "Curves in Colour."
November 12—Flying Officer D. R. P. Coats: "Telescopes."
December 10—Mr. L. W. Koser: "The Stars."

All meetings were open to the public. In addition two executive meetings were held.

The membership now stands at thirty-six. During the year five new members were elected; one resigned, and one left the city.

Margaret E. Watterson, *Secretary.*

Montreal Centre

At the beginning of the year it was decided to give a course of popular lectures with a view to giving new members an introduction to the main branches of astronomy. These lectures were all given by members of our Centre of the Society and with one possible exception were interesting and stimulating. In this respect I wish to thank Dr. Douglas, who came from Kingston to deliver one address. Mr. Henry F. Hall, our efficient and hard working Secretary, Mr. E. Russell Patterson, Dr. Bruce Ross and Mr. F. DeKinder our painstaking Treasurer, and Mr. Delisle Garneau.

Through the efforts of Mr. Delisle Garneau and Mr. Guimont, the Society now has access to an observatory. This, the Ville Marie Observatory, was constructed by Mr. Garneau and Mr. Guimont and now houses the Society's refracting telescope.

Due to the kindness and co-operation of Dr. A. Norman Shaw, Chairman of the Physics Department of McGill University, Mr. J. H. Magid and the Kiwanis Club of Montreal, the Society is now the owner of a new twelve-inch reflecting instrument.

The new Observatory has proved a great boom to the members

of the Society. Observation meetings were held each week during the summer months and were well attended.

Our thanks are expressed through Dr. A. Norman Shaw to McGill University for their kindness in allowing us the use of this room which is made so comfortable for us by Mr. Lane.

DAN P. GILLMOR, *President.*

VICTORIA CENTRE

Membership. In January 1942 the membership totalled 109, there being 3 life members, 10 juniors, 96 regulars. This year 19 members were lost for the following reasons: 2 deceased, 9 resigned, 8 dropped for non-payment of fees. During the year 11 new members have enrolled. The present membership stands at 101, divided as follows: life members 3, junior members 3, regular members 95; total 101.

Meetings. During the year 16 meetings were held: 7 regular meetings, 4 council meetings, 5 special summer course meetings. The general meetings were well attended, and keen interest was shown in the lectures which covered a wide range of subjects.

Summer Course. 18 members enrolled for the summer course, which included three lectures, a trip to the Observatory, and an outdoor meeting. Attendance was good throughout, and lectures were of an exceptionally high standard.

Conclusion. Although there has been a slight decrease in membership, 1942 has been a very successful year for our Centre. It is hoped that the Victoria Centre may find continued success throughout the coming year.

MIRA V. YARWOOD, *Secretary.*

LONDON CENTRE

During the year 1942 the London Centre held eight regular monthly meetings with a total attendance of 201. At each meeting Dr. Kingston directed a study of the OBSERVER'S HANDBOOK.

In an attempt to integrate the subject matter of the topics presented to the Society the addresses at the first four meetings were connected with "time." Other details of the separate meetings follow.

January 9—Address: "The Day," Dr. H. R. Kingston; Demonstration: The Foucault Pendulum, Dr. R. H. Cole. Attendance 29.

February 13—Address: "The Year," Dr. G. R. Magee; Demonstration: The precession of the equinoxes, Rev. W. G. Colgrove. Attendance 26.
March 13—Address: "Clocks," Mr. O. Kilburn; Demonstration: Construction of a sundial, Dr. R. H. Cole. Attendance 26.
April 10—Address: "Calendars," Dr. H. R. Kingston. Attendance 26.
May 8—Address: "The Milky Way," Rev. W. G. Colgrove; Demonstration: The new World Calendar, Dr. H. R. Kingston. Attendance 21.
May 30—The Annual Picnic, Wonacott's Farm.
October 9—Address: "The Romance of the Telecope," Dr. R. H. Cole; Demonstration: The Spectroscope, Dr. R. H. Cole. Attendance 28.
November 13—Address: Replaced by a motion picture of the Peace River Ditrict; Demonstration: The Sextant, Dr. R. H. Cole. Attendance 23.
December 11—Annual Meeting. Reports and election of officers; Address: "Galileo," Dr. G. R. Magee. Entertainment and Refreshments. Attendance 22.

The paid-up membership on December 11, 1942, is 38.

R. H. Cole, *Secretary*.

Edmonton Centre

Three council meetings were held during the year for the arrangement of programmes and other essential business.

Seven regular meetings have been held in the Arts Building, through the courtesy of the University authorities. The annual dinner meeting took place in the Corona Hotel. The average attendance was 32 members and visitors (five more than last year).

The Handbook talks during the year were given by Mr. Wates and by Dr. Campbell. Occasional other short talks on interesting developments in astronomy and the constellations were given by other members.

The main speakers and their subjects were as follows:
December 1941—Dr. J. A. Allan: "The First Thousand Million Years."
January 1942—Mr. J. A. McLean: "The Tides."
February—Mr. M. Crockford: "The Origin of the Earth."
March—Mr. C. G. Wates: "Some Limitations of Astronomy."
April—Mr. E. S. Keeping: "Asteroids."
May—Dr. D. B. Scott: "Universal Gravitation."
October—Mr. G. W. Robertson: "The Earth's Atmosphere."
November—Mr. C. G. Wates: "The Surface of the Moon."

An enjoyable observing picnic was held during the latter part of September. The social part was by invitation of Mrs. Clarke, President of the Centre.

The roll of the Centre consists of 46 regular members, 6 of whom live outside Edmonton. There are 6 associate members.

E. H. GOWAN, *Honorary Secretary.*

SECRETARY'S REPORT

VANCOUVER CENTRE

During 1942, three Council meetings and seven regular meetings were held in Room 200 of the Science Building of the University of British Columbia.

An excellent programme of addresses on interesting topics was enjoyed by members and their friends during the year.

The following is a list of speakers and their subjects:

January 13—Dr. H. V. Warren: "Minerals and Politics".
February 10—Dr. Andrew McKellar: "Comets and Meteors".
March 10—Dr. F. S. Harris: "The 200-inch Telescope".
April 14—Dr. C. S. Beals: "The Bright-line Stars".
October 13—Dr. Andrew McKellar: "The Aluminizing of Optical Surfaces".
November 10—Mr. Howard Edwards, M.A.: "Airline Weather Conditions Over the Rockies".
December 8—Dr. H. C. Gunning: "Meteorites".

The meetings were well attended, and invariably enlivened by spirited discussions at the close of the lectures. Monthly notices to the regular meetings were mailed to approximately 50 persons.

H. D. SMITH, *Secretary.*

QUEBEC CENTRE

ORGANIZATION.—At the very beginning of our activities, in 1940, the possibility of forming a Centre of the Royal Astronomical Society of Canada in Quebec City had already been seriously studied. As a matter of fact, Mgr. P. A. Choquette strongly exhorted us to organize a French Centre to which, he said, the majority of the amateurs of the Province would rally. But it was agreed that nothing would be done toward this end without the cordial approval of the proposal by Dr. C. A. Chant.

In a letter dated March 20, 1942, Mr. E. J. A. Kennedy, General Secretary, informed us that the General Council of the R.A.S.C. by resolution had recognized our astronomical organization as the Quebec Centre of the Society.

MEMBERSHIP.—A first list of twenty members was then sent to the General Secretary, with the amount of their fees. By the end of the year, there were on the list of the Quebec Centre 57 names of duly elected members of the R.A.S.C. The Junior Section was obliged to suspend its operations, owing to the Military Service which affected the majority of the members.

MEETINGS.—The Quebec Centre holds generally two meetings a month, a meeting of the Council and a familiar talk on a subject of present day or general interest which all the members are urged to attend. Three such meetings were held from March to December. The programmes were as follows:

May 29—"Idées récentes sur Jupiter," by M. Albéric Boivin.
November 11—"Notions de Spectroscopie," by M. l'abbé R. Benoit, Dean of the Faculty of Arts.
December 14—"Les Novae," par M. Albéric Boivin.

The regular meetings were suspended during the summer months. Besides these, the Quebec Centre organized two popular meetings in the Battlefield Park, where the society has its temporary observatory. The first was held on June 23, marking the installation of our dome, and the second on August 25, on the occasion of the eclipse of the moon.

The programme of the evening of June 23 consisted in the showing of the film entitled, "The Universe as seen to-day through Largest Telescopes," followed by the opportunity to look through one of the three telescopes installed on the platform of the Tower, inside the 16-foot dome and outside. During two long hours the crowd circulated in dense ranks, guided with ability by a troop of Boy Scouts of the City.

It was difficult to allow to pass unobserved an eclipe of the moon presenting so favourable circumstances as that of August 25. Another reason for organizing a night party was the installation under our dome of the 16-inch Foucault telescope, graciously offered to our Centre by Laval University. The organizer of our second popular meeting, Mr. J. C. Magnan, invited Mr. Jean Bruchési, Under-Secretary of the Province, to preside at the short ceremony to be held before the eclipse. In his address the representative of the Government stated that he had good reason to be satisfied with the

use that the Society was making of the grants secured through his recommendation, and added these words to be remembered, that the responsible leaders of our astronomical organization had more merit than the Government which "is doing only its duty in promoting the advancement of science."

After the presentation of a few moving pictures on instructive subjects and the reel on the moon from the series, "The Universe as seen to-day," the crowd, estimated by some to be 3,000 persons, was permitted to watch the evolution of the eclipse. Through a loud-speaker system, Mr. Gallichan transmitted to the audience the comments of two observers looking through the 16-inch reflector and the 4-inch refractor. During intermissions the narrator spoke of different theories of the colours appearing on the moon, or explained the particularities of the Saros, according to which there are repetitions of the same eclipse in 18 years 11 days. The constellations appearing in the growing darkness were also the subject of his remarks.

At these two meetings in the open air the organizers were really favoured by the weather, especially on June 23, when the sky was perfect after a morning with heavy showers.

At the Observatory of the Quebec Centre.—During the year, the temporary observatory of the Centre has been provided with an office built inside the Tower, and the 16-foot dome has been placed on a hexagonal base 5 feet high. The 16-inch telescope of Laval University was finally removed to the observatory and installed under the dome. The cost of materials for our total installation has amounted to $250; as to the manual work, it was performed by the members.

The installation, however, had not been completed at the end of summer and some further improvements were undertaken. During November the rolling cylinders under the dome were removed and could not be replaced because the workers were needed for other jobs. During the storm of December 2, one of the worst experienced at Quebec City (in a few hours the barometer fell to 27.6 inches), the dome was pushed aside between the base and the stone wall of the Tower. From this position the dome was easily blown off by the wind, and fell one hundred feet west of the Tower. By chance, the instruments were not touched and were found in the same position

as on the day before. After two weeks of work the dome was reshaped and made fit for use, but it was only at the end of January that the repairs were completely finished. Despite the disorganization of our observatory, our practical programme with the instruments was not suspended.

Although a great deal of the time devoted to observing is used to register sun-spots, aurorae and meteors, we are specially interested in variable star observations. MM. Pouliot and Nadeau, members of the A.A.V.S.O., have made nearly 600 estimates of brightness during the year.

At the observatory also is prepared a weekly astronomical article which is published in a local newspaper with wide circulation. Of the thirty-eight articles published during the year (the articles were suspended in February, March and April), twenty-two were prepared by Mr. Nadeau, four by M. Boivin, two by M. Pouliot and three by diverse contributors. The eight others were reprints or translations of articles published in astronomical magazines.

During one hour each evening when the sky is clear, the public is admitted in our observatory and given an opportunity to look through our instruments. The guest book was enriched with more than 1,000 new signatures during the year. This service, which is a hard test for the patience of our observers, has yielded nevertheless many interesting visits, especially from young people.

PAUL H. NADEAU, *Secretary*.

FINANCIAL STATEMENT, 1942

I. GENERAL TREASURER

GENERAL ACCOUNT No. 4359

CASH ON HAND DEC. 31, 1941			
General Account	$ 95.67		
Southam Press Fund	1,036.08		
			$1,131.75
RECEIPTS			
Grants received Ontario	$ 500.00		
Canada	1,620.00		
			2,120.00
Fees and Subscriptions:			
Members at large	$ 500.06		
Montreal Centre	454.00	($150 for 1941)	
Toronto	341.00		
Victoria	125.00		
Quebec	105.25		
Ottawa	98.00		
Hamilton	86.00		
London	72.00		
Winnipeg	67.00		
Vancouver	60.00		
			1,908.31
Publications			1,355.92
Interest on bonds	$ 72.88		
Bank interest and exchange	5.39		
U.S.A. Exchange	119.02		
			197.29
Total			$6,713.27

DISBURSEMENTS

Bonds purchased	$1,000.00
Publications	3,083.69
Public Meetings	49.00
Stamps and Stationery	275.11
Salary, Asst. Secretary-Treasurer	780.00
Grants to Centres	586.75
Rent	120.00
Janitor	18.00
Chant Medal	5.65
General Expense	78.01
Total	$5,996.21
Cash in Bank $686.46	
on Hand 14.84	
Interest coupons on Hand 15.76	
	717.06
	$6,713.27

BANK RECAPITULATION

Banks show balance	$1,054.09
Cheques outstanding	367.63
	$ 686.46

Audited and certified correct.

ANDREW THOMSON, *Auditor.*
F. L. HARVEY, *Auditor.*

J. H. HORNING,
General Treasurer.

II. REPORTS OF TREASURERS OF CENTRES

TORONTO CENTRE

RECEIPTS		DISBURSEMENTS	
Balance from previous year	$187.48	Rentals	$ 48.00
(191) Members' Fees	283.00	Fees to General Treasurer	283.00
Grant from General Council	174.00	Postage and Stationery	35.50
Bank Interest	nil	Expenses re meetings	60.00
			$426.50
		Cash in Bank	217.98
Totals	$644.48		$644.48

T. H. MASON, *Treasurer.*

OTTAWA CENTRE

Receipts		Disbursements	
Balance from previous year	$155.29	Fees to General Treasurer	$ 88.00
Members' Fees (43)	98.00	Postage and Stationery	8.10
Grant from Council	44.00	Expenses re meetings	22.37
Bank Interest	1.43	Exchange on Cheque	.15
Special contribution from two interested Ottawa members	50.00	Morrison Lamothe (catering)	16.00
		Balance carried forward	214.10
Totals	$348.72		$348.72

Audited and found correct.

D. B. NUGENT, *Auditor.* ANDREW C. STEEDMAN, *Treasurer.*

November 28, 1942.

HAMILTON CENTRE

Receipts		Disbursements	
Balance from previous year	$ 29.08	Rentals	$ 20.00
(38) Members' Fees	76.00	Fees to General Treasurer	86.00
Grant from General Council	49.00	Postage and Stationery	15.00
Bank Interest	.28	Expenses re meetings	13.00
Donation	5.64	Caretaker	1.00
		Balance carried forward	25.00
Totals	$160.00		$160.00

Audited and found correct.

WM. FINDLAY, *Auditor.* JAMES R. GRAHAM, *Sec.-Treas.*

December 7, 1942.

WINNIPEG CENTRE

Receipts		Disbursements	
Balance from previous year	$ 31.97	Rentals	$ 6.00
(33) Members' Fees	66.00	Fees to General Treasurer	67.00
Grant from General Council	32.50	Postage and Stationery	2.75
Bank Interest	.33	Expenses re meetings	2.00
		Exchange on Cheque	.15
		Balance carried forward	52.90
Totals	$130.80		$130.80

R. S. EVANS, *Treasurer.*

MONTREAL CENTRE

RECEIPTS		
Cash on hand and in Bank October 15, 1941		$287.68
Members' Fees (151½ at $2.00 each)	$303.00	
Grant from General Treasurer, Toronto	97.00	
Interest on Bank Deposits	4.57	
Total Received during the year		404.57
Total Cash Debit		$692.25

DISBURSEMENTS		
Membership Fees remitted to General Treasurer	$303.00	
Secretarial Services	1.00	
Sundry Expenses re meetings, including janitor and lantern services	32.50	
Postage and Post Cards	20.15	
Printing covering notices of meetings	7.56	
Stationery (letterheads and envelopes)	13.28	
Sundry General Expenses	1.05	
Library Expense, subscription to "Sky and Telescope"	2.50	
Publicity—Printing and Delivering Show Cards	21.48	
Photos of Observatory	2.00	
Total Disbursed during the year		404.52
LEAVING BALANCE ON HAND October 15, 1942, of		$287.73
Consisting of Cash on hand of	$ 7.35	
and Cash in Provincial Bank of	280.38	

Audited and found correct.

O. A. FERRIER,
(*Certified Public Accountant*).

F. DEKINDER,
Treasurer.

Montreal, October 21, 1942.

VICTORIA CENTRE

RECEIPTS		DISBURSEMENTS	
Balance from previous year	$ 52.43	Rentals	$ 14.00
(93) Members' Fees	131.50	Fees to General Treasurer	125.00
Grant from General Council	66.75	Postage and Stationery	8.83
Bank Interest	.17	Expenses re meetings	33.88
Summer Course Fees	18.00	Library Books and Periodicals	11.74
		Grant to Telescope Making Section	21.25
		Insurance on Property	7.30
		Sundries	15.20
		Balance carried forward	31.65
Totals	$268.85		$268.85

MIRA V. YARWOOD, *Secretary-Treasurer.*

LONDON CENTRE

Receipts		Disbursements	
Balance from previous year	$ 37.30	Rentals	$ 2.00
(37) Members' Fees	74.00	Fees to General Treasurer	72.00
Grant from General Council	39.00	Postage and Stationery	10.54
Bank Interest	.34	Expenses re meetings	1.82
		Books	8.65
		Miscellaneous	4.28
		Balance carried forward	51.35
Totals	$150.64		$150.64

Duly examined and certified correct.

G. W. HOFFERD.
December 11, 1942.

RANDAL H. COLE,
Secretary-Treasurer.

EDMONTON CENTRE

Receipts		Disbursements	
Balance from previous year	$123.40	Transparency	$ 7.89
(46) Members' Fees	70.00	Janitor's Account	3.35
Grant from General Council	50.00	Fees to General Treasurer	100.00
Bank Interest	.83	Expenses re meetings	10.35
Hand Books for Students (5)	2.50	Postage (Treasurer)	1.00
		Hand Books and Postage	4.06
		Banquet Guests	1.70
		Memorial Flowers	3.06
		1000 Post Cards and Printing	12.86
		50 Membership Cards	.35
		Charges on Cheque	.15
		Supplies for Secretary	2.55
		University Book Store Account	2.45
Totals	$246.73		$149.77

Total Receipts	$246.73
Total Expenses	149.77
Dec. 3rd, 1942. Balance on Hand	$ 96.96

Certified correct.
W. A. McAULAY, *Auditor.*

E. N. HIGINBOTHAM, *Treasurer.*

VANCOUVER CENTRE

Receipts		Disbursements	
Balance from previous year	$ 8.78	Rentals	nil
(31) Members' Fees	56.00	Fees to General Treasurer	$ 56.00
Grant from General Council	34.35	Postage and Stationery	18.22
Bank Interest	.23	Expenses re meeting	15.50
		Balance carried forward	9.64
Totals	$99.36		$99.36

LAURA ANDERSON, *Treasurer.*

CENTRE DE QUEBEC

Solde en banque, le 1er janvier 1942		$ 15.17
Encaissements		
Cotisations	$104.00	
Octroi Gouvernement Provincial, 1941	100.00	
Dons	13.46	
Octroi Gouvernement Provincial, 1942	150.00	
Participation Revue	38.30	
Intérêt de banque	.09	
		405.85
		$421.02
Paiements		
Salle de lecture	$ 78.38	
Ameublement	17.68	
Cotisations	105.25	
Chauffage et éclairage	80.97	
Papeterie et accessoires de bureau	27.90	
Timbres	4.07	
Assurance-feu, prime	2.00	
Démonstrations populaires	12.35	
Entretien	14.06	
Remboursement sur dette, 1941	50.00	
		392.66
Solde en banque, le 15 décembre 1942		$ 28.36

Vérifié et certifié ce 4 janvier, 1943.

LIONEL GALLICHAN, *Le Vérificateur.*

J. LUCIEN POULIOT, *Le Trésorier.*

OFFICERS FOR 1943

The Secretaries of the various Centres report the following officers elected for 1943:

TORONTO CENTRE

Honorary Chairman—C. A. CHANT, LL.D.
Chairman—MISS RUTH NORTHCOTT, M.A. *Vice-Chairman*—H. W. BARKER.
Secretary—TRACY D. WARING, 44 Rosepark Drive. *Treasurer*—T. H. MASON.
Recorder—F. L. TROYER. *Curator*—R. S. DUNCAN.
Council—D. S. AINSLIE, PH.D.; A. R. CLUTE, K.C.; L. GILCHRIST, PH.D.; J. F. HEARD, PH.D.; F. S. HOGG, PH.D.; J. H. HORNING, M.A.; REV. C. H. SHORTT; R. K. YOUNG, PH D.; W. T. PATTERSON, R.O.; MISS E. M. FULLER, B.L.S.; H. DUNCALFE; and *Past Chairmen*—J. R. COLLINS; E. J. A. KENNEDY; S. C. BROWN, and DR. D. W. BEST.

OTTAWA CENTRE

Honorary President—F. W. MATLEY. *President*—DR. T. L. TANTON.
First Vice-President—HOYES LLOYD.
Second Vice-President—MALCOLM M. THOMSON.
Secretary—F. W. MATLEY. *Treasurer*—ANDREW C. STEEDMAN.
Council—R. G. MADILL; DR. R. J. MCDIARMID; C. B. REILLY; H. M. BRADLEY; R. N. MCGREGOR. and *Past Presidents*—MISS MIRIAM S. BURLAND; JOHN MCLEISH; A. H. MILLER.

HAMILTON CENTRE

Honorary President—W. T. GODDARD, Box 428.
President—H. B. FOX, Sub-Station 28.
Vice-President—W. D. STEWART, B.A., 867 King St. E.
Secretary-Treasurer—J. R. GRAHAM, 64 Blake St.
Curator—T. H. WINGHAM, B.A.SC., 174 Aberdeen Ave.
Council—F. H. BUTCHER, B.A.; T. M. NORTON; DR. WM. FINDLAY; DR. A. E. JOHNS; G. E. CAMPBELL, M.A.; W. S. MALLORY, M.A.; REV. E. F. MAUNSELL; D. BURNS; MISS NELLIE CORKE.

WINNIPEG CENTRE

Honorary President—RIGHT REV. T. W. MORTON
President—MR. V. C. JONES, 109 Lanark St.
First Vice-President—MISS O. A. ARMSTRONG.
Second Vice-President—MR. W. P. JOHNSON.
Secretary—MISS MARGARET E. WATTERSON, 612 Toronto General Trusts Bldg.
Press Secretary—MISS O. A. ARMSTRONG.
Treasurer—MISS SHIRLEY COLQUETTE.
Council—MISS HAZEL BUCKNAM; FLYING OFFICER D. R. P. COATS; MR. R. D. COLQUETTE; MR. L. J. CROCKER; MR. L. W. KOSER; PROF. CARSON MARK; MR. H. E. RITER; MR. R. A. STORCH; PROF. L. A. H. WARREN.

MONTREAL CENTRE

Honorary President—MGR. C. P. CHOQUETTE
President—D. P. GILLMOR, K.C. *Vice-President*—MR. G. HARPER HALL.
Secretary—HENRY F. HALL, Sir Geo. Williams College, 1441 Drummond St.
Treasurer—MR. F. J. DEKINDER. *Recording Secretary*—MISS I. WILLIAMSON.
Council—O. A. FERRIER; A. M. DONNELLY; G. R. LIGHTHALL; F. P. MORGAN; E. R. PATERSON; DR. W. B. ROSS; DR. A. N. SHAW; J. W. DUFFIE; J. E. GUIMONT; DELISLE GARNEAU.

VICTORIA CENTRE

Honorary President—ROBERT PETERS *President*—O. M. PRENTICE
First Vice-President—A. MCKELLAR, PH.D.
Second Vice-President—K. O. WRIGHT, PH.D.
Secretary-Treasurer—MRS. M. V. YARWOOD.
Recorder—MISS ELIZABETH WALKER, B.A. *Librarian*—MISS Y. LANGWORTHY
Director of Telescope Making Section—W. HOBDAY
Council—G. L. DARIMONT; H. D. DAY; G. T. FREEMAN; J. MOULSON; M. TRUEMAN; DR. W. P. WALKER.

LONDON CENTRE

Honorary President—DR. H. R. KINGSTON.
Past President—T. C. BENSON. *President*—DR. G. R. MAGEE.
Vice-President—REV. M. E. CONRON.
Secretary-Treasurer—R. H. COLE, University of Western Ontario.
Council—D. M. HENNIGAR; J. W. BRYCE; E. H. MCKONE; A. EMSLEY; MISS C. CHAPMAN.

VANCOUVER CENTRE

Honorary President—DR. J. A. PEARCE, Dominion Astrophysical Observatory.
President—A. OUTRAM. *Vice-President*—N. D. B. PHILLIPS.
Recording Secretary—R. E. G. LANGTON, M.A.
Corresponding Secretary—H. D. SMITH, PH.D. *Treasurer*—E. G. BERTON.
Council—C. JORGENSEN; MRS. C. A. ROGERS; MRS. L. ANDERSON; H. P. NEWTON; W. PETRIE; DR. G. M. VOLKOFF; M. A. MCGRATH; G. T. GILPIN.

EDMONTON CENTRE

Honorary President—DR. J. W. CAMPBELL. *President*—DR. J. R. TUCK.
Vice-President—G. W. ROBERTSON. *Secretary*—PROF. E. H. GOWAN.
Treasurer—MISS ANNIE M. P. SMITH. *Librarian*—PROF. E. S. KEEPING.
Executive—MRS. CLARK *ex-officio;* C. G. WATES; W. ZINKAN; MISS JEAN WALLBRIDGE; ALEC STOCKWELL.
Social Hostesses—MISS M. O. BUCHANAN; MRS. J. M. CLINDININ.

CENTRE DE QUEBEC

Président honoraire—ARTHUR AMOS, I.C.
Président—MARIE-LOUIS CARRIER, I.C.
Vice-Président—LUCIEN MASSE, D.Sc.
Secrétaire—PAUL-H. NADEAU, 275, rue St-Cyrille, Québec.
Secrétaire-adjoint—MLLE LILIANE BEAULIEU.
Trésorier—LUCIEN POULIOT, C.G.A.
Conseil—ABBÈ R. BENOIT; JEAN-CHARLES MAGNAN; LIONEL GALLICHAN, directeur du Comité de vulgarisation; ALBÈRIC BOIVIN, directeur du cercle LÈON FOUCAULT; HENRI-PAUL KOENIG, *ex-officio*.

MEMBERS AT LARGE ELECTED SINCE MARCH, 1942

ANDERSON, P. NASH, 639 W. 29th St., Norfolk, Va.
ANDERSON, RUSSELL F., 2429 North Kildare Ave., Chicago, Ill.
ATHERTON, FREDERIC, 174 Osborn Rd., Harrison, N.Y.
ATTWOOD, J. ESTEN, 5160 Gloria Ave., Encino, Cal.
BLADEN, ROBERT, Holly Grange, Longsdon, Stoke-on-Trent, England.
CAMPBELL, CLARA C., 2442 Sixth St., Cuyahoga Falls, Ohio.
DESMOND, SENATOR THOMAS C., 94 Broadway, Newburgh, N.Y.
DREYFUS, R. M., 636 Greenwich St., New York, N.Y.
FASNACHT, DEWEY, 612 Canton Rd., Box 125, Ellet, Ohio.
GAUTHIER, REV. H., Collège du Sacré-Coeur, Sudbury, Ont.
HARKNESS, REED B., 4465 Forest Park Blvd., St. Louis, Miss.
HEAPS, R. T. C., 318 Duffield Ave., Moose Jaw, Sask.
HELMLE, HENRY R., 1110 First National Bank Building, Springfield, Ill.
IRELAND, R. H., Engineering Dept., Can. Nat. Railway, Calgary, Alta.
MADDEN, F. EDDY, D.D., 116 West Third, Liberal, Kansas.
MAYER, J. RICHARD, 134 Huntville Rd., Katonah, N.Y.
MCMULLEN, NYLE F., 121 Forrester St. S.W., Washington, D.C.
MONTGOMERY, WM. G., 1640 Oregon Ave., Philadelphia, Penna.
NELSON, NEWTON G., Moosonee, Ont.
OSHINSKY, A., 8420 20th Avenue, Brooklyn, N.Y.
RAPEE, ERNO R., Radio City Music Hall, Rockefeller Centre, New York, N.Y.
RESZETNIK, C., 125 Walter St., Kitchener, Ont.
RYERSON, K. A., College of Agriculture, Univ. of Calif., Davis, Cal.
SETLOW, JOHN C., 593 South Paddock St., Pontiac, Mich.
TYRREL, R. E., 110 Greenwich St., New York, N.Y.
TJON SIE FAT, R. H., 521 Noordstraat, Oranjestad, Aruba, N.W.I.
VAUGHN, FRANK, 159 Sycamore Ave., Plainfield, N.J.
WHITMER, H. L., 2719 Somme Avenue, Norfolk, Va.
WYSONG, BURR, 700 Columbus Avenue N.W., Canton, Ohio.
YORDANOFF, DAKO, P.O. Box 8, Geraldton, Ont.

NOTES AND QUERIES

Communications are invited, especially from amateurs. The Editor will try to secure answers to queries.

Tercentenary of the Invention of the Barometer

In 1643 Toricelli invented the barometer, and established the ideas of atmospheric pressure. This presented a new approach to physical science. The Royal Meteorological Society, Canadian Section, passed a resolution that this discovery be commemorated. The Royal Astronomical Society of Canada has been asked to share in the ceremony.

The tentative plans call for meetings to be held on October 19, at the University of Toronto. The University and the Royal Canadian Institute, together with the Meteorological and Astronomical Societies, will sponsor the ceremony. It is planned to have an afternoon meeting, of a more technical kind, and an evening meeting, with two papers of a more popular type. A more detailed announcement of the meetings, and the complete programme, will be published at a later date.

F. S. H.

Celebration of the Newton Tercentenary

In our last number was an article reprinted from *The Times Literary Supplement* in which it was suggested that the Royal Society should undertake the publication of Newton's works. The February 20 issue of the same weekly periodical refers to a statement by the president of the Royal Society that, owing to present conditions, certain features of the celebration had to be postponed and one of them was the publication of a complete edition of Newton's works and letters. The president is quoted further as saying:

> My immediate object is to bring to wider notice the recognition which has been given to Newton's achievement, and the homage done to his memory, by the men of science and the Government of one of our great allies, Soviet Russia. Commemorative meetings were held on the anniversary of Newton's birth, according to the Russian calendar, by the Soviet Academy of Sciences of Moscow and by a number of other scientific academies, societies, and associations in different parts of the U.S.S.R. . . . Finally, the central Soviet Government has honoured the occasion by announcing, through the Commissar of Education, the creation of fifteen Newton Scholarships tenable at the universities of the U.S.S.R. by students specializing in Newton's own fields of mathematics, physics, mechanics, and astronomy.

C. A. C.

A Newish Moon clears the Horizon

Reading "The Gaunt Woman" by Edmund Gilligan (Scribners), I really enjoyed a first class spy and espionage story which deals with the sea, but astronomically it cannot be relied on, because he says on page 83, telling the events of the evening: "The brilliant spread of sunset went out then, and the night swarmed over the square-rigger." All right, but on page 91: "The moon was rising. It was a newish one, and would lend but little light to the scene. Yet Patrick longed for that light, and determined to wait until he had it."

The situation was tense, and if he didn't have moonlight he might stumble and the Germans on board the square-rigger would hear him. So, on page 94 the reader is glad to read that: "The moon had now cleared the horizon and its light made their going easy. The moon sent irregular flashes of light through the skylight and through another port that lay open beyond."

Everything turned out satisfactorily, but one shudders to think what might have happened had the "newish moon" gone down with the sun, as nature intended. There is no further mention of the moon, and the reader may take his choice,—either down it himself or, as the author did, leave the poor thing out all night.

F. T. S.

Pluto—its Mass, Diameter, Density

In a Note by H. S. J. in *The Observatory* of December 1942 interesting information regarding the planet Pluto is given, as follows:

The most reliable estimate of the mass of Pluto yet available has been derived by L. R. Wylie from a comparison of observations of Newton from 1795 to 1938 with Newcomb's Tables. The work, details of which are given in the Publications of the U.S. Naval Observatory, Washington, vol. 15, part 1, was undertaken to provide a reduction of the available observations on a uniform basis for the revision of the theory of Neptune which is being made by Dr. Brouwer of Yale.

The mass of Pluto was derived from the discussion of both longitudes and latitudes of Neptune. The separate results were:

From longitudes	$0.251 \pm 0.060 \times 10^{-5}$ sun's mass.
From latitudes	$0.314 \pm 0.031 \times 10^{-5}$ sun's mass.

The weighted mean is $0.300 \pm 0.028 \times 10^{-5}$ sun's mass, which corresponds to a mass of Pluto intermediate between the masses of Venus and the earth.

No prediscovery observations of Neptune except these of Lalande in 1795 were used. The effect of Pluto upon Neptune's motion cannot be separated from

corrections to the orbital elements in the solution from the longitude if this is restricted to the observations from 1846 onwards. The solution from the longitudes therefore depends heavily upon the Lalande observation. The solution in latitude is more favourable, because of the high inclination of the orbit of Neptune and because conjunction of Pluto and Neptune occurred in 1870. The solution from the latitudes will be affected, however, by any systematic error in the declination of the stars in the FK3 system. An investigation of this question leads to the conclusion that it is not possible to change the mass of Pluto by as much as 50 per cent. without assuming that the declination system of the FK3 catalogue is in need of corrections larger than appears to be probable.

The mass of Pluto is larger than *a priori* consideration suggested. Assuming that the density of Pluto does not exceed that of the earth, which is the most dense of all the other planets, and that its albedo is not lower than that of Mercury, which has the lowest albedo of all the other planets, upper limits to the mass of Pluto, corresponding to visual magnitudes of 14.0 and 14.5, are 0.7 and 0.4 times the mass of the earth. If the density of Pluto is equal to that of the earth, and its apparent diameter is d'', the mass of Pluto is $12.6d^3$ times the mass of the earth. With the mass of Pluto derived by Wylie, the apparent diameter of Pluto should be about 0.″4 and the disc should be clearly visible in a large telescope under favourable conditions of seeing. An accurate determination of the magnitude of Pluto and a careful examination of its image in large telescopes for signs of a visible disc are much to be desired.

C. A. C.

Lunar Eclipse of February 19-20, 1943

Mr. E. K. White of Chapman Camp, B.C., has supplied the following account of this eclipse. He enclosed three excellent photographs taken with his 9-inch reflector, which we regret we are unable to reproduce.

Kimberley and Chapman Camp residents were fortunate in having a perfectly clear sky on the night of the partial eclipse of the moon, February 19-20.

Transparency was perfect (5) and when the moon was completely immersed in the penumbra it was difficult to notice any dimness even in the telescope. As the moon immersed in the umbra shadow the sky became much less brilliant, until near maximum immersion Comet Whipple 2, quite close to Gamma of Ursa Major, was easily seen with the naked eye. It has only been telescopic here since last February 11 owing to the moon light. From 10.00 p.m. until after 11.00 p.m., the southern portion of the moon was decidedly dark red. In the telescope the Tycho bright ray-streaks could be easily seen while immersed in the umbra, in fact a lot of detail could be seen on the shadowed area of the moon, and quite a beautiful aspect it was in the dark red light. I was unable to see well the greenish umbra-penumbra border as is often seen during lunar eclipses.

As is well known by lunar observers, an eclipse offers a possibility of observing lunar meteors. The luminous streak could be seen against the dull shadowed area of the moon, and the existence of such luminous streaks would prove the moon does possess at least a rare atmosphere. A careful study of the eclipsed area was made at my observatory during most of the umbra immersion, in an effort to catch a possible glimpse of a lunar meteor, but none were seen.

C. A. C.

METEORIC IRON IN ANCIENT EGYPT

Although known as the "Ore of Heaven" from the New Kingdom, iron ore does not appear to have been smelted for general use as tools and weapons until the Twenty-fifth Dynasty [712-663 B.C.]. In fact the problem of the use of iron in Egypt has formed the subject of much controversy. The earliest definitely dated specimens of iron are a number of small tubular beads found in a small predynastic [i.e., before 3400 B.C.] cemetery at El-Gerza. Although completely converted into rust, chemical examination showed that they contained 7½ per cent. of nickel, and thus were almost certainly of meteoric origin.

* * * * * * *

Iron is stated in the Book of the Dead to be the necessary material for certain amulets, but until the Twenty-fifth Dynasty it seems to have been a rarity only obtained from meteorites, though perhaps occasionally imported as well.—"The Legacy of Egypt" (1942), pages 135, 136.

C. A. C.

MEETINGS OF THE SOCIETY

AT TORONTO

February 2, 1943.—The Society met in the McLennan Laboratory, University of Toronto, at 8.00 p.m., Miss Ruth J. Northcott in the chair.

Dr. Helen S. Hogg presented the first in a new series of short talks on "Major Advances of the Twentieth Century in Astronomy." She dealt with the discovery of Pluto, the ninth planet. The discovery of Neptune in the 19th century was based on mathematical predictions made independently by Adams

in England and Leverrier in France to explain perturbations of Uranus from its orbit. "It was one of the great triumphs of mathematical astronomy when the planet was found by Galle at Berlin in 1846," Mrs. Hogg said.

Because small perturbations were still found in Uranus' orbit, Percival Lowell in 1905 began a search for a trans-Neptunian planet which he named Planet X. Four years later, after a mathematical study of the residuals in the orbit of Uranus, W. H. Pickering published predictions for the possible location of a planet which he called Planet O. Lowell died in 1916 but the search for the new object went on at the observatory which he established at Flagstaff, Arizona. Pickering revised his computations on the basis of perturbations in Neptune's orbit as well as that of Uranus. Failure to find the supposed planet in a search of plates made at the Mount Wilson Observatory tended to discourage the search for some years.

In 1929 a powerful new 13-inch refractor was put into operation at the Lowell Observatory on a systematic program of photographing the region of the ecliptic, and an object, believed to be the long-sought planet, was found on a plate taken on January 21, 1930. The secret was kept, however, for several weeks while additional photographs were made to ensure that the moving object was not an asteroid. On Lowell's birthday, March 13, 1930, the observatory at Flagstaff announced to the world that the ninth planet had been found, and it was later named Pluto and given a symbol incorporating the initials of Percival Lowell's name.

Re-examination of plates made at Mount Wilson in 1919 showed the planet had been photographed at that time but that it was concealed by a defect in the plate in one instance and was superimposed over a star in another.

Captain G. D. Frewer was introduced by Mr. H. G. Duncalfe and spoke on "Astronomy as Used in Navigation." He described the use of trigonometry in navigation and the instruments used in finding a ship's location. Navigation by dead reckoning—log, lead, lookout and latitude—he said, was based on plane trigonometry. In navigating by nautical astronomy, spherical trigonometry is used together with the sextant. Until the middle of the 18th century, no chronometer was sufficiently accurate for determining longitude. A prize was offered by the British government for an improved timepiece and was won by John Harrison in 1765.

Captain Frewer described his work in testing and adjusting ships' compasses. "The magnetic compass is always in trouble, and it is necessary to check it at every possible opportunity," he said. "The compass is most important in sailing by dead reckoning, when it is impossible to make observations of the sun and stars." An approximate determination of latitude may be made by noting the elevation of the pole star when a sextant or artificial horizon cannot be used for more accurate observation, he said. Following his address, Captain Frewer answered several questions asked by members and demonstrated the marine compass, sextant and other instruments.

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